

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
1 July 2004 (01.07.2004)

PCT

(10) International Publication Number  
**WO 2004/055526 A2**

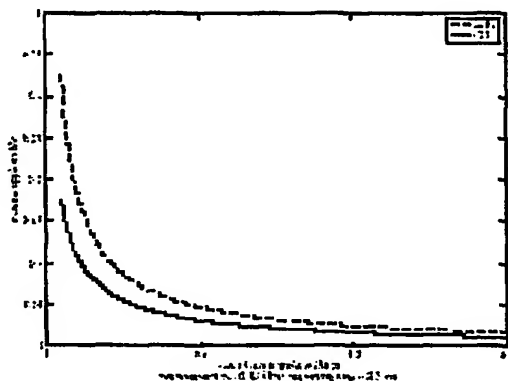
- (51) International Patent Classification<sup>7</sup>: **G01R**
- (21) International Application Number:  
PCT/US2003/039714
- (22) International Filing Date:  
12 December 2003 (12.12.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
60/433,407 13 December 2002 (13.12.2002) US
- (71) Applicant (for all designated States except US): **THE TRUSTEES OF THE UNIVERSITY OF PENNSYLVANIA** [US/US]; 3160 Chestnut Street, Philadelphia, PA 19104-6283 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **EPSTEIN, Charles, L.** [US/US]; 2022 Addison Street, Philadelphia, PA 19146 (US). **MAGLAND, Jeremy** [US/US]; 262 Elm Court, North Wales, PA 19454 (US).

- (74) Agents: **CALDWELL, John, W.** et al.; Woodcock Washburn LLP, One Liberty Place - 46th Floor, Philadelphia, PA 19103 (US).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

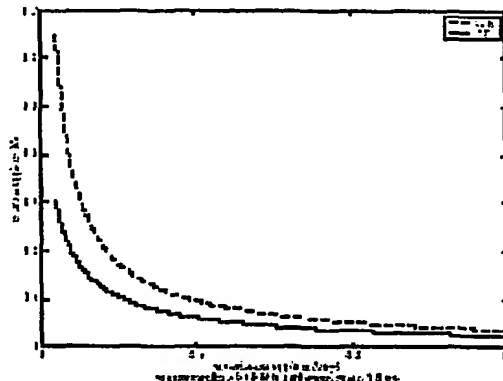
Published:  
— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: PRACTICAL PULSE SYNTHESIS VIA THE DISCRETE INVERSE SCATTERING TRANSFORM



(a) Transition width = 0.3 KHz,  
rephasing time = 2.0 ms



(b) Transition width = 0.1 KHz,  
rephasing time = 5.0 ms

(57) Abstract: The discrete inverse scattering (DIST) approach is used to design selective RF pulses. As in SLR, a hard pulse approximation is used to actually design the pulse. Unlike SLR, the pulse is designed using the full inverse scattering data (the reflection coefficient and the bound states) rather than the flip angle profile. The reflection coefficient is approximated in order to obtain a pulse with a prescribed rephasing time. In contrast to the SLR approach, direct control on the phase of the magnetization profile is retained throughout the design process. Explicit recursive algorithms are provided for computing the hard pulse from the inverse scattering data. These algorithms are essentially discretizations of the Marchenko equations. When bound states are present, both the left and right Marchenko equations are used in order to improve the numerical stability of the algorithm. The DIST algorithm is used in preferred applications to generate pulses for use in magnetic resonance imaging, although it has applications in other two-level quantum systems such as quantum computing and spintronics.

WO 2004/055526 A2



---

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*